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(12) **UK Patent Application** (19) **GB** (11) **2 010 794 A**

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- (21) Application No. 7849231  
(22) Date of filing 20 Dec 1978  
(23) Claims filed 20 Dec 1978  
(30) Priority data  
(31) 2757576  
(32) 23 Dec 1977  
(33) Fed. Rep. of Germany (DE)  
(43) Application published  
4 Jul 1979  
(51) INT CL<sup>2</sup>  
C01B 31/08  
B01D 53/02  
(52) Domestic classification  
C1A J241 J270 J285 J387  
J393 J3 J403 J407 J421  
J423 J424 J453 J454 J462  
J601 J602 J613 J614  
B1L 102 210 205 206 302  
305 309 AE  
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(58) Field of search  
B1L  
C1A  
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**(54) Activated carbon**

(57) The activated carbon comprises activated carbon impregnated with one or more chromium compound, one or more heavy metal salt and one or more alkali metal iodide. The heavy metal salt may be a salt of Fe, Co, Ni, Cu, Ag or Au, and the activated carbon may also be impregnated with iodine.

Although the compounds present undergo undesired reaction with each other and sometimes with the carbon, the impregnated activated carbon can be used to provide a compact filter (e.g. in respiratory devices) for adsorbing radioactive iodine and compounds thereof as well as other harmful gases (e.g. chlorine cyanide) from air.

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## SPECIFICATION

### Activated charcoal and process for its production

- 5 This invention relates to an activated charcoal intended for use as an air purifying means and to a process for its production.

Activated charcoal is used in various apparatuses for purifying respiratory air of harmful gases, for example, in respiratory protective filters which are carried by the user or in filters in fixed ventilation installations.

It is known to impregnate the charcoal with salts of heavy metals. The term "heavy metal" is used herein, in both the description and claims, to mean a metal having in its elemental form a density of more than 5 grams per cubic centimetre. More particularly it is known to produce an activated charcoal which contains all three of copper salts, chromates and silver nitrate, which activated charcoal is effective for absorbing prussic acid and chlorine cyanide.

Activated charcoals impregnated with potassium iodide or with both potassium iodide and iodine are also known, which are useful for neutralising acidic gases, such as hydrogen sulphide, and also for neutralising mercury vapours; such charcoals are also known for absorbing radioactive iodine and its compounds, in connection with air purification in nuclear installations.

When air is to be purified by filtering of both radioactive iodine and/or compounds containing radioactive iodine, and also acidic gases or harmful gases which are catalytically decomposable or which are to be chemically neutralised, it has been necessary hitherto to place several activated charcoal layers which are variously impregnated or not impregnated, separated from one another and enclosed in air filter units, in the air stream, so that the impurities mentioned above are removed from the air successively in one or other of the activated charcoal layers. This requires the use of a large quantity of activated charcoal and as a result the filters become heavy and space-consuming. A great deal of material is used for the filters and manufacturing costs are generally high. Bulky, heavy filters are difficult to handle and when carried by a user restrict the freedom of movement of the user.

What is required is an activated charcoal which can be used for filtering not only radioactive iodine and its compounds, but also harmful gases from air, which harmful gases are catalytically separable or are to be chemically neutralised, in order to reduce the total quantity of activated charcoal.

According to the present invention there is provided activated charcoal comprising charcoal impregnated with one or more chromium compound and one or more heavy metal salt, and also with one or more alkali metal iodide.

Preferably the alkali iodide comprises potassium iodide.

An activated charcoal, according to the present invention, should enable the amount of charcoal required for a given installation to be reduced,

whilst providing the necessary filtering capacity for the harmful gases. The activated charcoal according to the present invention, may well be easy to manufacture and to fit into respiratory protective filters. The low weight necessary for protective respiratory filters and other filters can still be retained. It has proved possible to impregnate a charcoal with chromium compounds and heavy metal salts together with alkaline iodides, although, as expected, the activated charcoals impregnated with chromium compounds and heavy metal salts and additionally impregnated with alkali iodides resulted in undesired chemical reactions. The chemicals with which the charcoal is impregnated, do indeed enter into uncontrolled reactions with each other and if the occasion arises also with the activated charcoal, which at least impairs the desired efficiency of the activated charcoal. It was expected that at least the heavy metal salts would enter catalytically into inactive compounds with the iodine. Furthermore, it was expected that, when the alkali iodide comprised potassium iodide, the chromium compounds of higher valency would oxidise the potassium iodide. However, the adverse effects of such reactions are less expected and, surprisingly, permit a workable filter material to be produced.

The activated charcoal may also be impregnated with iodine.

Preferably the heavy metal of the heavy metal salt is selected from iron, cobalt, nickel, copper, silver and gold. Preferably at least one heavy metal salt is a copper salt.

Preferably at least one chromium compound is selected from chromates and dichromates.

Advantageously, at least one chromium compound has an oxidation state of less than +6. Chromites may be used as chromium compounds having an oxidation state of less than +6. Activated charcoal which is impregnated with such compounds is less likely to suffer from the harmful effects of atmospheric humidity on its sorptive capacity with respect to harmful substances.

The present invention also provides a process for producing an activated charcoal according to the present invention of the type mentioned, wherein the activated charcoal is firstly impregnated with an aqueous solution of one or more heavy metal salt and one or more chromium compound and then dried, and then impregnated with an aqueous solution of an alkali metal iodide and dried.

The chromium compound(s) may be selected from chromates and chromium compounds having an oxidation state of less than 6. Advantageously, when a copper salt is used as the heavy metal salt, the aqueous solution of the heavy metal salt(s) includes ammonia in order to increase the solubility of the copper salts with respect to the solubility of chromates.

The present invention further provides a process for producing an activated charcoal impregnated with a copper salt, wherein charcoal is impregnated with an aqueous suspension of a compound of both copper and chromium having an oxidation state of less than +6, which compound is produced by heating copper ammonium chromate,

and the impregnated charcoal is dried, and then the dried charcoal is impregnated with an aqueous solution of an alkali metal iodide and dried. The process may be modified by impregnating the charcoal with the aqueous suspension of the copper and chromium compound and simultaneously with an aqueous solution of the alkali metal iodide, after which the impregnated charcoal is dried.

Alternatively, charcoal impregnated with a copper salt may be produced by a process wherein the charcoal is impregnated with an aqueous solution of an alkali metal iodide and dried, and then impregnated with an aqueous suspension of a compound of both copper and chromium, and dried.

It is advantageous to use potassium iodide as the alkaline iodide, and also to impregnate the charcoal with iodine.

In order to improve the penetration of the impregnating means into the activated charcoal, the charcoal may before impregnation be subjected to a sub-atmospheric pressure. For the same purpose, the impregnation of one or more stages may also be effected at a sub-atmospheric pressure.

During the first impregnation stage, in which the activated charcoal is firstly impregnated with an aqueous solution of the heavy metal salts and chromium compounds and then dried, the drying may take place at temperature of up to 200°C. Drying can be effected in this temperature range even when the solution of the heavy metal salts contains chromium compounds having a degree of oxidation of less than +6.

When two impregnation stages are effected, the charcoal may be dried at a temperature of up to 100°C. Furthermore, when only one impregnation stage is carried out in which impregnation is carried out simultaneously with alkaline iodide and chromite, the charcoal may be dried at a temperature of up to 100°C.

So that the activated charcoal is carefully processed, the drying may be effected at a sub-atmospheric pressure.

For a better understanding of the present invention and to show more clearly how the same may be carried into effect, a description will now be given of an exemplary embodiment of the present invention.

Granular charcoal of a particle size of approx 1 mm is subjected to an absolute pressure of 10 mbar and then impregnated with an ammoniacal solution of copper carbonate and ammonium chromate at a concentration such that the copper proportion of the copper compounds impregnating the activated charcoal amounts to approximately 6% by weight and the chromium proportion of the applied chromium compound amounts to approximately 2% by weight of the activated charcoal. The impregnated activated charcoal is dried at a temperature of 150°C and subjected to an increasing sub-atmospheric pressure until an absolute pressure of 5 mbar is obtained. The activated charcoal impregnated in this way is then cooled to room temperature and, also under sub-atmospheric pressure, impregnated with a solution of potassium iodide and iodine, the concentration of this

solution being such that, in the impregnated activated charcoal in its final state, the quantity of potassium iodide is approximately 1.5% by weight of the activated charcoal and the quantity of iodine is approximately 1% by weight of the activated charcoal. The activated charcoal is, after the second impregnation, dried at approximately 100°C and subjected to a sub-atmospheric pressure until an absolute pressure of 5 mbar is attained.

The activated charcoal prepared in accordance with the exemplary embodiment, has good catalytic and chemo-sorptive properties, whilst retaining a good physical adsorptive power. In addition, this activated charcoal should be able to effect a high level of separation of radioactive iodine from air, even when the iodine is present in very volatile compounds such as methyl iodide. The activated charcoal impregnated in accordance with this exemplary embodiment has a separating efficiency, measured in accordance with standard testing techniques used in nuclear technology, of 99.9996% for radioactive methyl iodide. Furthermore, this activated charcoal has an absorption power for chlorine cyanide of 8g per 100 g of activated charcoal.

#### CLAIMS

1. Activated charcoal comprising charcoal impregnated with one or more chromium compound and one or more heavy metal salt, and also with one or more alkali metal iodide.

2. Activated charcoal as claimed in claim 1, wherein the alkali metal iodide is potassium iodide.

3. Activated charcoal as claimed in claim 1 or 2 wherein the activated charcoal is also impregnated with iodine.

4. Activated charcoal as claimed in claim 1, 2 or 3, wherein the heavy metal of the heavy metal salt is selected from iron, cobalt, nickel, copper, silver and gold.

5. Activated charcoal as claimed in claim 4, wherein at least one heavy metal salt is a copper salt.

6. Activated charcoal as claimed in any one of the preceding claims, wherein at least one chromium compound is selected from chromates and dichromates.

7. Activated charcoal as claimed in any one of the preceding claims, wherein at least one chromium compound has an oxidation state of less than +6.

8. Activated charcoal substantially as described in the foregoing example.

9. A process for producing an activated charcoal as claimed in claim 1, wherein the activated charcoal is impregnated with an aqueous solution of one or more heavy metal salt and one or more chromium compound and then dried, and then impregnated with an aqueous solution of an alkali metal iodide and dried.

10. A process according to claim 9, wherein the chromium compound(s) is/are selected from chromates and chromium compounds having an oxidation state of less than +6.

11. A process according to claim 9 or 10, where-

in, when the heavy metal salt comprises a copper salt, the aqueous solution of the heavy metal salt(s) includes ammonia.

12. A process for producing an activated charcoal as claimed in claim 5, wherein charcoal is impregnated with an aqueous suspension of a compound of both copper and chromium having an oxidation state of less than +6 which compound is produced by heating copper ammonium chromate, and the impregnated charcoal is dried, and then the dried charcoal is impregnated with an aqueous solution of an alkali metal iodide and dried.

13. A process for producing an activated charcoal as claimed in claim 5, wherein the charcoal is impregnated with an aqueous solution of an alkali metal iodide and dried, and then impregnated with an aqueous suspension of a compound of both copper and chromium, and dried.

14. A modification of the process according to claim 12, wherein the charcoal is impregnated with the aqueous suspension of the copper and chromium compound and simultaneously with an aqueous solution of the alkali metal iodide, after which the impregnated charcoal is dried.

15. A process according to any one of claims 9 to 14, wherein before the, or at least one, impregnation the charcoal is subjected to a sub-atmospheric pressure.

16. A process according to any one of claims 9 to 15 wherein the impregnation is carried out at a sub-atmospheric pressure.

17. A process according to any one of claims 9 to 16 wherein the charcoal after the or the first impregnation is dried at a temperature of up to 200°C.

18. A process according to any one of claims 9 to 17 wherein, when two impregnation stages are employed, the charcoal, after the second impregnation stage, is dried at a temperature of up to 100°C;

19. A process according to any one of claims 9 to 18 wherein drying is effected at a sub-atmospheric pressure.

20. A process for producing activated charcoal substantially as described in the foregoing example.